(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) Publication number: **0 333 423 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication of patent specification: **13.07.94**

(51) Int. Cl.5: **H05B 6/64**, A21B 7/00, A21B 2/00

(21) Application number: **89302476.0**

(22) Date of filing: **14.03.89**

The file contains technical information submitted after the application was filed and not included in this specification

(54) **Heat generating container for microwave oven.**

(30) Priority: **14.03.88 JP 61590/88**
16.06.88 JP 149095/88
16.06.88 JP 79757/88

(43) Date of publication of application:
20.09.89 Bulletin 89/38

(45) Publication of the grant of the patent:
13.07.94 Bulletin 94/28

(84) Designated Contracting States:
DE FR GB

(56) References cited:
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EP 0 333 423 B1

Description

The present invention generally relates to high frequency heating arrangements and more particularly, to heat generating vessels or containers for use in types of high frequency heating apparatus, for example microwave ovens in which heat is generated through irradiation with microwaves from a high frequency generating source (e.g. a magnetron) for heating and baking an object to be cooked.

A microwave oven is a cooking apparatus arranged to irradiate an object to be cooked, located in the interior of an oven or heating chamber, with microwaves emitted from a magnetron so as to effect cooking by causing the object to generate heat itself.

However, there are some items that require cooking that cannot be heated directly by microwaves. These include those items that require browning or those in which the preliminary processing includes fermentation by raising the temperature thereof.

In order to adequately cook the items referred to above, a microwave oven further provided with a sheathed heater in the heating chamber has been proposed in the prior art in order to irradiate the item to be cooked with heat from the sheathed heater as well as encouraging self heat generation through irradiation with the microwaves.

Such microwave ovens must provide two heat sources, i.e., a magnetron and a sheathed heater. This not only involves an increase in cost, but also requires the construction of the microwave oven to be undesirably complicated, because of the consequent increase in the size of the apparatus as a whole.

In order to overcome the various problems described above, a heat generating member comprised of a double layered plate formed by laminating a substance which generates heat through irradiation of microwaves (e.g., silicon carbide, ferrite or the like) and an inorganic heat insulating base material (e.g., glass, ceramic or the like) has recently been developed in the prior art. A heat generating member made of a silicon carbide group ceramic moulded plate has also been proposed in the prior art.

Microwave ovens employing the types of heat generating member described above are capable of effecting both dielectric heating and heating through heat radiation, through irradiation with microwaves alone. Such microwave ovens are referred to as multi-function microwave ovens.

Incidentally, due to the fact that so-called "home bakeries" or household bread baking units have recently become popular, microwave ovens provided with a bread baking function have been studied and manufactured and are commercially available.

Bread baking containers or hoppers (referred to as hoppers hereinafter) for placing in the interior of an oven or in the heating chamber of a microwave oven are generally heated indirectly. This requires there to be parts which subject heated air to convection for the efficient conduction of heat to the hopper. Accordingly, not only are costs increased, but power consumption is also raised undesirably due to the poor heating efficiency possible, even when the heat is conducted in an efficient manner.

An alternative, direct heating practice has conventionally been proposed in which a microwave absorbing heat generating material is applied over an outer surface of a hopper as disclosed in Japanese Patent Laid-open Publication Tokkaisho No. 58-52916, or as disclosed in Japanese Patent Laid-open Publication Tokkaisho No. 58-52917 in which a microwave absorbing heat generating material is coated on a ceramic or glass container.

However, these known arrangements are prone to problems such as uneven baking (or scorching), and the unwanted killing of yeast for fermentation if used for bread making, because of the transmission of microwaves into the container.

Some conventional multi-function microwave ovens use microwave irradiation alone for both microwave heating and the heating through heat radiation. As heating through heat radiation does not kill yeast as does microwave heating, such ovens can be used in bread baking devices widely employed recently and for composite cooking. Known bread baking devices include a hopper for accommodating materials such as flour and the like, which has an outer face coated with a microwave absorbing heat generating material. The hopper is placed on a bottom plate of the heating chamber of a microwave oven. The bread baking devices also include a kneading device comprising a stirring blade, and a metallic open-close lid that provides the upper portion of the hopper and is attached to the lower part by way of a clip fixture for shielding microwaves is also provided. An outer cover made of a heat-resistance glass or the like encloses the above arrangement.

The known bread baking devices described above, have disadvantages. One such disadvantage is that as the entire outer surface of the hopper is coated with microwave absorbing heat generating material and the upper portion of the hopper is shielded by the metallic open/close lid, if no turntable or stirrer fan is provided, heating may be uneven resulting in uneven browning or perhaps scorching. This is because microwave radiation that passes through the outer cover, onto the microwave absorbing heat generating material has an uneven distribution. There is also a possibility that

the heat generating material will be subjected to local overheating and portions of it will melt. Moreover, because the heat generating material coating is directly on the outer surface of the hopper, the material tends to deteriorate due, for example, to separation or cracking by sintering, that may arise through handling when grasping the hopper when bread is taken out, careless collision with other utensils, or washing of the hopper. This presents problems with durability. Furthermore, since clip fixtures are used to secure the open/close lid in position there is the possibility that as bread swells during the final stage of baking it will be compressed by the open/close lid and burst when the clip fixture is released.

Prior art document US-A-4-663-506 discloses a microwave cooking vessel which utilises a microwave absorbing material which absorbs microwave energy to produce heat.

The present invention aims to provide a heat generating container for a microwave oven or the like, which is not readily damaged during cooking or washing, thereby improving its durability and which has a simple construction for reduction of cost.

In accomplishing the above aim the invention provides a cooking apparatus for use in a microwave oven, comprising: a microwave absorbing heat generating material having a high dielectric loss for generating heat by absorbing microwaves; a container for accommodating foodstuffs to be cooked; and a cover; characterised by said microwave absorbing heat generating material being located on a surface of said cover, said cover being adapted to substantially enclose said container and to be supported by an open rim of said cover placed around said container and said cover being supported by said rim.

The microwave absorbing heat generating film layer referred to above is prepared by coating with a paint including 10 to 60% of resin such as silicon, epoxy, urethane, polyester resin, etc. having a heat-resistance over 150 °C, ferrite powder, and a sealing material. The microwave absorbing heat generating film layer could also be formed by plasma spray coating or flame coating with ferrite and SiC. The outer surface of the microwave absorbing heat generating film layer can be further covered by a microwave transmitting and heat-resistant paint for example, a paint containing methylphenylsilicone resin, and ethylene tetrafluoride resin, polyether sulfone resin, polyphenyl sulfone resin or the like.

With the arrangement of the present invention, microwave irradiation causes the cover to generate heat itself by self-heat generation utilising microwaves and the microwave absorbing heat generating film layer, making it possible to achieve high heating efficiency. Because the construction of the microwave oven for heating the cover of the present invention is simple compared to that of microwave ovens providing means for indirect heating, cost reductions are also achievable. The cover can be made of a metallic material which is a good heat conductor to reduce uneven heating, while advantageously preventing microwaves from penetrating the cover. Moreover, the microwave transmitting and heat-resistant coating protects the microwave absorbing heat generating film layer, while improving the appearance of the product.

A preferred embodiment of the present invention aims to provide an improved bread baking device for a microwave oven in which the microwave absorbing heat generating material is arranged not to be locally overheated even by uneven irradiation of microwaves, and also not to be readily damaged during cooking or washing, thereby to present a bread baking device capable of effecting uniform and favourable bread baking, with a superior durability.

In accomplishing the above aim, according to a preferred embodiment of the present invention, there is provided a bread baking device comprising cooking apparatus according to an afore-mentioned aspect of the invention, in which bread baking device the container accommodates bread ingredients, and comprises a stirring device for kneading the bread ingredients contained in the container, and the cover is made of, or has its inner surface made of, metal.

With the arrangement of the present invention, after kneading the ingredients placed in the container with the stirring device, the cover is mounted on the bottom plate in the heating chamber so as to cover the container and the stirring device. Then, upon irradiation of microwaves onto the outer cover from above, the microwave absorbing heat generating material on the surface of the outer cover, generates heat through absorption of the microwaves, and this generated heat is conducted to the cover with a high heat conductivity for rapid diffusion, while the microwave absorbing heat generating material at a low temperature obtains heat from the cover for temperature rise. Accordingly, the above heat generating material rises in its temperature generally uniformly even when it is subjected to uneven microwave irradiation, without being fused or melted by local overheating, and thus, the container within the cover is generally uniformly heated from its entire peripheral portion, thereby to provide good bread having a uniformly scorched portion over its surface. Furthermore, since the heat generating material and the container are provided in a separated construction, there is no possibility that the heat generating member is damaged during insertion or withdrawal,

or washing of the hopper.

In another embodiment, the present invention aims to provide an improved bread making device for accommodating bread materials wherein there is provided a lid for the container. The lid is adapted to make a sliding fit with the container such that the walls of the lid and of the container overlap. Thus the lid of the container can slide upwards as the bread in the container swells during cooking or fermentation, thereby inhibiting compression of the bread. The walls of the lid must be of sufficient length such that upon swelling of the bread and the lid rising upwards, the walls of the lid remain in sliding contact with the walls of the container.

In a further embodiment the present invention aims to provide a microwave absorbing heat generating member which is free from fusion or melting by local overheating even when subjected to uneven irradiation of microwaves.

In accomplishing the above object, according to the further embodiment of the present invention, there is provided a microwave absorbing heat generating member, which includes a base member made of a metallic plate having a high heat conductivity and formed with a large number of through-holes, and a ceramic layer containing a microwave absorbing heat generating material with a high dielectric loss to generate heat by absorbing microwaves, and covering said base member to be integrally formed therewith.

By the above construction, when microwaves are irradiated onto the heat generating member constituted by the metallic base member having many through-holes and the ceramic layer containing the microwave absorbing heat generating material and covering said base member to be integral therewith, the microwaves are absorbed into the microwave absorbing heat generating material in the ceramics at the reverse face side of the base member via the many through-holes as well as into the ceramics at the front face side of said base member, and thus, the ceramic material generates heat comparatively uniformly at the front and reverse face sides thereof. The heat generated by the ceramic material is conducted to the base member with a high heat conductivity for rapid diffusion through said base member, while the ceramic material at a low temperature is raised in its temperature by the heat obtained from said base material. Accordingly, the microwave absorbing heat generating material having the construction as described above is raised in temperature generally uniformly even when subjected to uneven microwave irradiation, without any possibility of fusing or melting by the undesirable local overheating.

These and other aims and features of the present invention will become clear from the following description taken in conjunction with the preferred embodiments thereof with reference to the accompanying drawings, in which:

Fig. 1 shows a general construction of a bread baking container according to a first embodiment of the present invention;

Fig. 2 is a schematic diagram showing a general construction of a microwave oven provided with the bread baking container of Fig. 1;

Fig. 3 shows a general construction of a bread baking container according to a second embodiment of the present invention;

Fig. 4 is a fragmentary cross section of a microwave absorbing heat generating member which may be employed in the arrangement of Fig. 3;

Fig. 5 is a perspective view showing a general structure of a base member employed in the heat generating member of Fig. 4; and

Fig. 6 is a perspective view of the heat generating member including the base member of Fig. 5 and ceramics as integrally formed therewith.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals through the accompanying drawings.

Referring further to Fig. 2, there is schematically shown a microwave oven M2 in which a bread baking device 15 according to a second embodiment of the present invention is adopted.

The microwave oven M2 in Fig. 2 includes the housing H in which the heating chamber 4 is defined, the magnetron 1, the waveguide 2, the waveguide cover 3 provided at the microwave energy feed opening O, and the bread baking device 15 provided on the bottom plate 4a in the heating chamber 4 as illustrated.

The bread baking device 15 referred to above includes a circular pan 16 of heat-resistant plastics (glass fiber containing polyphenylene sulfide resin) fixed on the bottom plate 4a, a gear case 17 of a stirring device mounted on the bottom plate 4a to extend upwardly through a central opening 16a of said pan 16, a cylindrical hopper 18 of stainless steel for accommodating bread material 19 such as flour or the like, fixed on the upper face of said gear case 17, with an upper end of a driving shaft 17a which projects upwardly from said gear case 17 extending through a central opening 18b formed in a bottom portion 18a of said hopper 18, a stirring blade 10 fixed at the forward end of said driving shaft 17a, a cup-shaped outer cover 11 of copper detachably fitted over said plan 16 so as to cover said hopper 18 and gear case 17 from above, and ceramic layers 12 and 12' containing SiC (silicon carbide) as the microwave absorbing heat generating material and formed on the inner surface of said outer cover 11.

The ceramic layers 12 and 12' are provided respectively to fill up a recess 13 formed by draw-

ing on a ceiling portion of the outer cover 11, and another recess 13' formed by drawing on the cylindrical portion of the outer cover 11 approximately from its central portion downwardly in a width equal to 1/3 to 1/2 of its total height to extend around the entire periphery of said cylindrical portion.

More specifically,SiN (silicon nitride) powder containing 40 to 70% of Sic is applied into the recess 13, while SiN powder containing 70 to 85% of SiC is applied into the recess 13' respectively, and these painted layers are held in a calcinating or sintering furnace at temperatures of 800 to 900 °C together with the outer cover 11, and thus, ceramic layers 12 and 12' of 3 to 5 mm in thickness, with a porosity of about 30% are formed. Otherwise, the layers 12 and 12' may be formed in such a manner that after flame spray coating of alumina into the recesses 13 and 13', the ceramic layers 12 and 12' having the above compositions and separately prepared by sintering are bonded thereto by a ceramic bonding agent, silicon sealer of a heat-resistant organic material, etc. Then, after forming the face of the outer cover 11 into a smooth surface without any stepped portions by sealing boundary portions between the ceramic layers 12 and 12', and the outer cover 11, etc. with a sealing material, a close adhering non-adhesive and high temperature resistant organic resin such as fluorine, silicon, polyethersulfone, or polyphenylene sulfide resin, etc. is subsequently applied onto the surface treated as above so as to form a top coat 14. The ceramic layers 12 and 12' as the microwave absorbing heat generating material thus formed, generate heat and rise in the temperature upon receipt of continuous irradiation of microwaves within the heating chamber 4, and heat the interior of the outer cover 11 up to temperatures in the range of 150 to 170 °C through convection, and similarly, heat the interior of the outer cover 11 up to a proper fermentation temperature of the bread material by yeast through reception of intermittent microwave radiation following the ON/OFF control based on a sensor and an electronic circuit (not shown).

Operations and functions of the bread baking device 15 as described so far will be explained hereinafter.

the outer cover 11 of the bread baking device 15 disposed in the heating chamber 4 of the microwave oven M2 in Fig. 2 is detached to place the bread material 19 such as flour or the like into the hopper 18, and then, a stirring blade 10 fixed at the upper end of the driving shaft 17a is rotated to knead the bread material. When the bread material has been sufficiently kneaded, the outer cover 11 is fitted onto the pan 16 to cover the hopper 18 from above to complete the setting. Subsequently, the microwaves generated by the magnetron 1 are irradiated onto the outer cover 11 from above. Then, the ceramic layers 12 and 12' as the microwave absorbing heat generating material on the surface of the outer cover 11 generate heat through absorption of the microwaves, and the heat thus produced is rapidly diffused as it is conducted through the outer cover 11 of copper having high heat conductivity, while the ceramic layer 12' subjected to less microwave irradiation as compared with the ceramic layer 12 receives heat from the outer cover 11 for temperature rise and heat generation. Accordingly, even when subjected to such non-uniform microwave irradiation, the ceramic layers 12 and 12' are raised in the temperature generally evenly, and uniformly heat the hopper 18 in the outer cover 11 from the entire periphery through convection without being fused or melted by local overheating. In other words, they heat the hopper 18 up to the optimum fermenting temperature during fermentation by yeast, and the temperatures in the range of 150 to 170 °C during bread baking period respectively.

In the above case, the yeast contained in the bread material 19 shielded from the microwaves by the outer cover 11 of copper and further, by the hopper 18 of stainless steel, effects the fermentation of flour without being damaged, and thus, the bread material is finished for baking by the above heating, with the surface of the baked bread being uniformly formed with the brown scorching. Moreover, close to the completion of the baking, the bread material 19 swells up so as to overflow the hopper 18, but even in such a case, the bread is allowed to swell in the natural state due to absence of any lid or the like which obstructs the swelling, and there is no possibility of bursting of bread during withdrawal of baked bread by removing the lid as in the conventional practice. Moreover, since the ceramic layers 12 and 12' as the microwave absorbing heat generating material are not coated onto the hopper 18 itself, they are not damaged by insertion or withdrawal of the hopper during baking of bread or by washing of the hopper after baking, thus providing a remarkable durability.

It should be noted here that the present invention is not limited in its application to the foregoing embodiment alone, but may be modified, for example, in such a manner that, with the outer cover 11 of copper replaced by an outer cover of aluminum, the top coat 14 of high temperature resistant organic resin is replaced by a top coat of ceramic material, while the ceramic layer 12' for the outer cover 11 may be formed only at four directions instead of the entire periphery of the cylindrical portion as in the foregoing embodiment. Meanwhile, for the microwave absorbing heat generating material, besides the ceramic layers 12 and 12' in the foregoing embodiment, it may be possible to

employ a painted film containing ferrite powder properly selected according to the magnetic characteristics at high concentration (e.g., 80%) (for example, a painted film prepared by methylphenyl-silicone resin paint baked at 280 °C for 20 minutes so as to be in the thickness of 200 to 500 μm). In this case, the recesses 13 and 13' described as formed on the outer cover 11 are not necessarily required, and it may be so arranged to modify the film thickness at the ceiling portion to 100 to 200 μm or to change the film thickness on the cylindrical face to 300 to 500 μm, or further, to alter the film thickness at the ceiling portion to 300 to 500 μm, thereby to form the scorching to a larger extent over the supper surface of the bread.

As is seen from the foregoing description, the bread baking device for the microwave oven according to the first embodiment of the present invention is provided with the hopper placed on the bottom plate of the heating chamber for the electronic oven for accommodating therein materials for bread such as flour and the like, the stirring device for kneading the bread materials contained in the hopper, and the outer cover in the cup-shape detachably disposed on the bottom plate of the heating chamber so as to cover the hopper and the stirring device, and formed on its inner surface, with the microwave absorbing heat generating material layers which have a high dielectric loss to generate heat by absorbing the microwave. Therefor, even when subjected to uneven irradiation of microwaves, the device is capable of rising temperature of the heat generating material for heat generation generally uniformly by the outer cover, thus enabling the bread material within the hopper to be uniformly heated by the heat convection, etc. Moreover, by the construction in which the heat generating material is separated from the hopper, such heat generating material is free from damages during cooking or cleaning for use in favourable conditions for long periods.

Referring further to Fig. 4, there is shown a fragmentary cross section showing on an enlarged scale, construction of a microwave absorbing heat generating member F according to a second embodiment of the present invention. The microwave absorbing heat generating member F in Fig. 4 generally includes a base member 41 made of a copper plate or aluminium plate (in this embodiment, it is made of a copper plate) formed with many square through-holes 41a, a porous ceramic (alumina, titania, zirconia or the like) layer 42 formed over the entire surface of said base member 41 by plasma flame spray coating, and another ceramic material 43 made of SiN (silicon nitride) containing SiC (silicon carbide) which is the microwave absorbing heat generating material for generating heat through absorption of microwaves and integrally molded to cover said base member 41 as illustrated.

As shown in Fig. 5, the through-holes 41a are formed in the base member 41 in a lattice-like pattern through punching by press work, and each of the through-holes 41a is set to be larger than 3 mm^2 for permitting the microwaves to be effectively transmitted therethrough, and to be smaller than 10 mm^2 so as not to deteriorate the heat conductivity of the base member 41. The ceramic layer 42 formed over the surface of the base member 41 is intended to improve close adhesion of the ceramic material 40 to be formed thereover and to prevent deformation, crack formation and separation during use for long periods through absorption of thermal expansion difference. Meanwhile, the ceramic material 43 referred to above is prepared in such a manner that after homogenous mixing by a ball mill, of a mixture prepared by 60 to 90% of SiC particles, 10 to 30% of SiN fine powder, and a small amount of bentonite, with addition thereto of a trace quantity of polyvinyl alcohol aqueous solution, the resulting mixture is dehydrated and granulated by a spray dryer. Then, the base member 41 is buried in the ceramic particles thus prepared, and charged into a metal mold for molding by press work into a plate-like shape, and subsequently, the molded member thus prepared is sintered by holding in a sintering furnace at temperatures of 800 to 900 °C for integral molding into the configuration as shown in Fig. 9. In this case, since the sintering temperatures are comparatively low at 800 to 900 °C, the base member 41 made of, for example, copper or the like is not adversely affected. The microwave absorbing heat generating member F for the microwave oven, with outputs, for example of 500 to 1000 W, prepared in the above described manner has such dimensions that, in Fig. 7, the thickness Y of the base member 41 is set to be 30 to 40% of the total thickness X of said heat generating member for preventing local overheating and achieving proper heat generating temperatures, with the thicknesses x1 and x2 of the ceramic material 43 at the upper and reverse sides of the heat generating member F being set to be generally equal to each other.

Subsequently, functions of the microwave absorbing heat generating member F described so far with reference to Figs. 4 to 6 will be explained hereinafter.

On the assumption that microwaves are irradiated onto the surface of the microwave absorbing heat generating member F, the microwaves are absorbed not only into the ceramic material 43a at the upper face side of the base member 41, but also into SiC as the microwave absorbing heat generating material in the ceramic material 43b at the reverse face side of the base member 41

through the many square through-holes 41a, and thus, the ceramic material 43 generates heat comparatively uniformly on the upper and reverse face sides at high heat generating efficiency. The heat generated by the ceramic material 43 is conducted to the base member 41 having a large thermal capacity, with high heat conductivity for rapid diffusion through said base member 41, while the ceramic portion at low temperatures is raised in its temperature by obtaining heat from the base member 41. In the above case, since the through-holes 41a are provided by the dimensions described earlier at a proper density, with the base member 41 and the plastic materials 43a and 43b at both sides having the thickness as stated earlier and the entire surface of the microwave absorbing heat generating member F is covered by the ceramic material 43 containing SiC, said heat generating member generates heat and is raised in its temperature even when subjected to uneven microwave irradiation, without any possibility of local overheating for being melted. Moreover, by the presence of the intermediate layer 42, durability is markedly improved. Accordingly, it becomes possible to uniformly heat the baking container by the microwave oven in which such microwave absorbing heat generating member F is properly provided within the heating chamber, and thus, said heat generating member F of the present invention may be said to have a particularly wide application.

A bread baking device 35 employing the microwave absorbing heat generating member as described so far may be applied to the microwave oven having the same construction as that described earlier with reference to Fig. 2. Within the microwave oven in Fig. 2, the microwaves generated by the magnetron 1 are led into the heating chamber 4 via the waveguide 2 through the feed opening O provided with the waveguide cover 3 so as to be irradiated onto the replaced bread baking device 35 disposed on the bottom plate 4a of the heating chamber 4.

As shown in Fig. 3, the bread baking device 35 referred to above includes a circular pan 36 of a heat-resistant plastic material (glass fiber containing polyphenylene sulfide resin) in which a heat insulating material 37 made of an expandable fibrous ceramics and the microwave absorbing heat generating member F as described earlier with reference to Fig. 4 are laminated, and a gear case 39 of a driving unit erected on the bottom plate 4a of the heating chamber 4 so as to extend upwardly through a central through-hole 36a of said pan 36, a cylindrical hopper 20 of stainless steel for accommodating bread material 21 such as flour or the like, fixed on the upper face of said gear case 39, with an upper end of a driving shaft 39a which projects upwardly from said gear case 39 extending through a central opening 20b formed in a bottom portion 20a of said hopper 20, a stirring blade 22 fixed at the forward end of said driving shaft 39a, a cylindrical lid 23 of stainless steel having an annular groove 23a to be fitted onto an upper edge 20c of said hopper 20 and many small holes 23b formed therein and slidably fitted (in directions indicated by arrows A) over the upper portion of the hopper 20, and a cup-shaped outer cover 24 of a heat-resistant plastic material fitted over said pan 36 so as to cover said hopper 20 and gear case 39 from above. On the ceiling portion of the outer cover 24 confronting the cylindrical lid 23, a recess 25 is formed to provide scorching on the upper surface of the based bread, and over the surface of said recess 25, a silicone resin film 26 containing 60 to 80% of ferrite as the microwave absorbing heat generating material is applied in thickness in the range of 200 to 300 μm.

Operations and functions of the bread baking device 35 as described so far will be explained hereinafter.

The outer cover 11 of the bread baking device 35 disposed in the heating chamber 4 of the microwave oven in Fig. 2 is detached to charge the bread material 21 such as flour or the like into the hopper 20, and then, the stirring blade 22 fixed at the upper end of the driving shaft 39a is rotated to knead the bread material. When the bread material has been sufficiently kneaded, the cylindrical lid 23 is applied onto the hopper 20, and the outer cover 24 is fitted onto the pan 36 to cover the hopper 20 from above to complete the setting. Subsequently, the microwaves generated by the magnetron 1 are irradiated onto the outer cover 24 from above. The microwaves thus projected are absorbed into the microwave absorbing heat generating member F on the pan 36 through the outer cover 24, and the heat generating member F is raised in its temperature to generate heat generally uniformly so as to heat the hopper 20 from its entire peripheral portion through convection. Meanwhile, the above microwaves are also absorbed by ferrite in the silicone resin film 26 on the surface at the ceiling portion of the outer cover 24, and the heat generated thereby heats the upper surface of the bread material 21 through the cylindrical lid 23.

In the above case, the yeast contained in the bread material and shielded from the microwaves by the hopper 20 of stainless steel and the cylindrical lid 23 effects the fermentation of flour without being damaged, and thus, the bread material is finished for baking by the above heating, with the surface of the baked bread being uniformly formed with the brown scorching. Moreover, close to the completion of the baking, the bread material swells up so as to overflow the hopper 20, but even in such a case, the bread is allowed to swell in the

natural state owing to upward sliding movement of the cylindrical lid 23 without compressing the bread material, and there is no possibility of bursting of bread during withdrawal of baked bread by removing the cylindrical lid as in the conventional practice. It should be noted here that although the above microwave absorbing heat generating member F is located partly behind the hopper 20, whereby the irradiation of the microwaves tends to be non-uniform, owing to the construction as described with reference to Fig. 4, it generates heat generally uniformly, without any possibility of melting by the local overheating as in the conventional arrangement. In other words, the function of the heat generating member F as described above makes it possible to effect an ideal bread baking. Moreover, since the above microwave absorbing heat generating member F and the silicone resin film 26 containing ferrite are not directly coated on the hopper itself as in the know arrangements, they are not damaged during insertion and withdrawal of the hopper in the baking of bread or during washing of the hopper after baking, and thus, in cooperation with the function of the intermediate ceramic layer 42 as described earlier with reference to Fig. 4, a remarkable durability may be achieved.

It should also be noted here that, in the foregoing embodiment, although the pan 36 is described as made of polyphenylene sulfide resin, the material of the pan is not limited to the above, but may be replaced, for example, by a microwave transmitting material containing an inorganic filling agent or heat-resistant and impact resistant ceramic or glass material. Moreover, the heat-resistant plastic material employed for the outer cover 24 may be replaced by heat-resistant glass or metallic material, and in the case where metallic material is used, it is necessary to employ a lath sheet in the form of wire mesh or a metallic sheet formed with many holes by punching operation for permitting microwaves to be transmitted therethrough. Furthermore, the base member 41 for the microwave absorbing heat generating member F in the embodiment of Fig. 4 may be formed by aluminum instead of copper.

As is clear from the foregoing description, the microwave absorbing heat generating member F according to the present invention as described with reference to Figs. 4 to 9 is constituted by the base member made of a metallic plate having a high heat conductivity and formed with many through-holes, and the ceramics layer containing the microwave absorbing heat generating material with a high dielectric loss to generate heat by absorbing the microwaves, and covering the base member to be integrally formed therewith, and therefore, it is raised in its temperature for heat generation generally uniformly through rapid heat diffusion by the base member, even when subjected to non-uniform microwave irradiation, whereby the heat generating member of the present invention is capable of uniformly heating cooking containers and the like through simple and inexpensive construction for wide applications to replace conventional electric heaters.

Although the present invention has been fully described in connection with the preferred embodiments thereof with reference to the accompanying drawings, it is to be noted that various changes and modifications are apparent to those skilled in the art.

Claims

1. Cooking apparatus for use in a microwave oven, comprising:

   a microwave absorbing heat generating material (12,12';26;43) having a high dielectric loss for generating heat by absorbing microwaves;

   a container (18;20) for accommodating foodstuffs (19;21) to be cooked; and

   a cover (11;24) characterised by said microwave absorbing heat generating material (12,12';26) being located on a surface of said cover (11;24), said cover (11; 24) being adapted to be placed over and to substantially enclose said container (18;20) and to be supported by an open rim of said cover (11;24), said rim being placed around said container (18;20).

2. Cooking apparatus according to claim 1 wherein said microwave absorbing heat generating material (12,12';26) is disposed in one or more recesses (13,13';25) formed in a surface of said cover (11;24).

3. Cooking apparatus according to claim 2 wherein said cover (11;24) includes a circumferential side wall and a top wall, or ceiling, and wherein a first of said recesses (13;25) is formed in said top wall, and a second of said recesses (13') is formed as a circumferentially continuous recess in said side wall.

4. Cooking apparatus according to any of claims 1 to 3, wherein said cover (11;24) further includes an outer heat resistant coating (14).

5. Cooking apparatus according to any preceding claim, wherein an inner surface of said cover (11;24) is made of metal.

6. Cooking apparatus according to any of claims 1 to 4, wherein said container is made of

metal.

7. A bread baking device comprising cooking apparatus according to claim 5 or claim 6 for use in a microwave oven wherein:

said container (18;20) accommodates bread ingredients (19;21), and comprises a stirring device (10;22) for kneading said bread ingredients (19;21) contained in said container (18;20); and

said cover (11;24) is adapted to substantially enclose said container (18;20) and stirring device (10;22).

8. A bread baking device, or cooking apparatus as claimed in any preceding claim, wherein said container (18;20) has a lid (23) capable of being pushed upwardly by said foodstuffs (19;21) as they swell during cooking, thereby to inhibit compression of said foodstuffs (19;21).

9. A bread baking device or cooking apparatus as claimed in any preceding claim, including a base member (41) in the form of a metallic plate having a high thermal conductivity wherein are formed a number of through holes (41a), said base member (41) being covered by a material (43) containing said microwave absorbing heat generating material (43).

10. A bread baking device or cooking apparatus as claimed in any preceding claim, wherein said cover (11;24) is of a material having a high thermal conductivity.

Patentansprüche

1. Kochgerät zur Verwendung in einem Mikrowellenofen, mit:
   - einem mikrowellenabsorbierenden, wärmeerzeugenden Material (12, 12'; 26; 43) mit hohem dielektrischem Verlust zum Erzeugen von Wärme durch Absorbieren von Mikrowellen;
   - einem Behälter (18; 20) zum Aufnehmen zuzubereitender Speisezutaten (19; 21); und
   - einem Mantel (11; 24);

   dadurch gekennzeichnet, daß das mikrowellenabsorbierende, wärmeerzeugende Material (12, 12'; 26) an der Oberfläche des Deckels (11; 24) angeordnet ist, und der Mantel (11; 24) so ausgebildet ist, daß er über dem Behälter (18; 20) angeordnet ist und diesen im wesentlichen einschließt, und er von einem offenen Rand des Deckels gehalten wird, welcher Rand um den Behälter (18; 20) herum angeordnet ist.

2. Kochgerät nach Anspruch 1, bei dem das mikrowellenabsorbierende, wärmeerzeugende Material (12, 12'; 26) in einer Vertiefung oder mehreren (13, 13'; 25) angeordnet ist, die an einer Oberfläche des Mantels (11; 24) ausgebildet sind.

3. Kochgerät nach Anspruch 2, bei dem der Mantel (11; 24) eine Umfangswand und eine obere Wand oder Deckenwand aufweist, und bei dem eine erste der Vertiefungen (13, 25) in der oberen Wand und eine zweite der Vertiefungen (13') als kontinuierliche Umfangsvertiefung in der Seitenwand ausgebildet ist.

4. Kochgerät nach einem der Ansprüche 1 bis 3, bei dem der Mantel (11; 24) ferner einen äußeren, wärmebeständigen Überzug (14) aufweist.

5. Kochgerät nach einem der vorstehenden Ansprüche, bei dem die Innenseite des Mantels (11; 24) aus Metall besteht.

6. Kochgerät nach einem der Ansprüche 1 bis 4, bei dem der Behälter aus Metall besteht.

7. Brotbackgerät mit einem Kochgerät nach Anspruch 5 oder Anspruch 6 zur Verwendung in einem Mikrowellenofen, bei dem:
   - der Behälter (18; 20) Brotzutaten (19; 21) aufnimmt, und er eine Rührvorrichtung (10; 22) zum Kneten der Brotzutaten (19; 21) im Behälter (18; 20) aufweist; und
   - der Mantel (11; 24) so ausgebildet ist, daß er den Behälter (18; 20) und die Rührvorrichtung (10; 22) im wesentlichen umschließt.

8. Brotbackgerät oder Kochgerät nach einem der vorstehenden Ansprüche, bei dem der Behälter (18; 20) über einen Deckel (23) verfügt, der von den Speisezutaten (19; 21) nach oben geschoben werden kann, wenn diese während des Zubereitungsvorgangs gehen, um ein Zusammendrücken der Speisezutaten (19; 21) zu verhindern.

9. Brotbackgerät oder Kochgerät nach einem der vorstehenden Ansprüche, mit einem Trägerteil (41) in Form einer Metallplatte mit hohem Wärmeleitvermögen, in der eine Anzahl Durchgangslöcher (41a) ausgebildet sind, wobei das Trägerteil (41) mit einem das mikrowellenabsorbierende, wärmeerzeugende Material (43) enthaltenden Material (43) beschichtet ist.

10. Brotbackgerät oder Kochgerät nach einem der vorstehenden Ansprüche, bei dem der Mantel (11; 24) aus einem Material mit hohem Wärmeleitvermögen besteht.

Revendications

1. Appareil de cuisson destiné à être utilisé dans un four à micro-ondes comportant:

une matière génératrice de chaleur absorbant les micro-ondes (12, 12'; 26;43) présentant une perte dielectrique élevée pour engendrer de la chaleur en absorbant les micro-ondes;

un récipient (18,20) pour recevoir des aliments (19;21) à cuire; et

un couvercle (11;24),

caractérisé en ce que ladite matière génératrice de chaleur absorbant les micro-ondes (12,12';26) se situe sur une surface dudit couvercle (11;24), ledit couvercle (11;24) étant adapté de manière à être placé par-dessus ledit récipient (18;20) et à l'enfermer sensiblement, et à être supporté par un rebord ouvert dudit couvercle (11;24), ledit rebord étant placé autour dudit réciplent (18;20)

2. Appareil de cuisson selon la revendication 1, dans lequel ladite matière génératrice de chaleur absorbant les micro-ondes (12,12';26) est disposée dans un ou plusieurs évidements (13,13';25) formés dans une surface dudit couvercle (11;24)

3. Appareil de cuisson selon la revendication 2, dans lequel ledit couvercle (11;24) comprend une paroi-latérale circonférentielle et une paroi supérieure ou plafond, et dans lequel un premier évidement desdits évidements (13;25) est formé dans ladite paroi supérieure, et un second évidement desdits évidements (13') est formé de façon à constituer un évidement circonférentiellement continu dans ladite paroi latérale.

4. Appareil de cuisson selon l'une quelconque des revendications 1 à 3, dans lequel ledit couvercle (11;24) comprend en outre un revêtement externe résistant à la chaleur (14).

5. Appareil de cuisson selon l'une quelconque des revendications précédentes, dans lequel une surface interne dudit couvercle (11;24) est réalisée en métal.

6. Appareil de cuisson selon l'une quelconque des revendications 1 à 4, dans lequel ledit récipient est réalisé en métal.

7. Dispositif de cuisson de pain comportant un appareil de cuisson selon la revendication 5 ou la revendication 6 destiné à être utilisé dans un four à micro-ondes, dans lequel:

ledit récipient (18;20) reçoit des ingrédients pour faire du pain (19;21), et comporte un dispositif d'agitation (10;22) pour malaxer lesdits ingrédients pour faire du pain (19;21) contenus dans ledit récipient (18;20); et

ledit couvercle (11;24) est adapté de manière à entourer sensiblement ledit récipient (18;20) et ledit dispositif d'agitation (10;22)

8. Dispositif de cuisson de pain ou appareil de cuisson selon l'une quelconque des revendications précédentes, dans lequel ledit récipient (18;20) a un dessus (23) apte à être repoussé vers le haut par lesdits aliments (19;21) lorsqu'ils lèvent au cours de la cuisson pour inhiber ainsi la compression desdits aliments (19;21).

9. Dispositif de cuisson de pain ou appareil de cuisson selon l'une quelconque des revendications précédentes comprenant un élément de base 41 se présentant sous la forme d'une plaque métallique ayant une conductivité thermique élevée et dans laquelle est formée un certain nombre de trous débouchants (41a), ledit élément de base (41) étant recouvert d'un matériau (43) contenant ladite matière génératrice de chaleur absorbant les micro-ondes (43).

10. Dispositif de cuisson ou appareil de cuisson selon l'une quelconque des revendications précédentes, dans lequel ledit couvercle (11;24) est réalisé en une matière présentant une conductivité thermique élevée.

Fig. 1

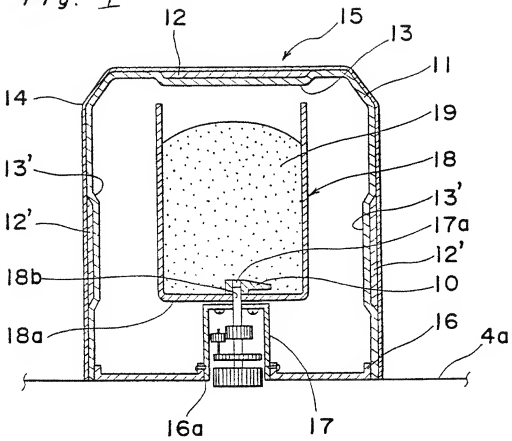
12
15
13
11
14
19
18
13'
13'
12'
17a
12'
18b
10
16
18a
4a
16a
17

Fig. 2

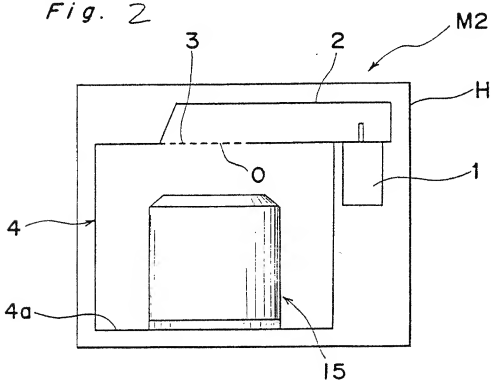
M2
3
2
H
0
1
4
4a
15

Fig. 3

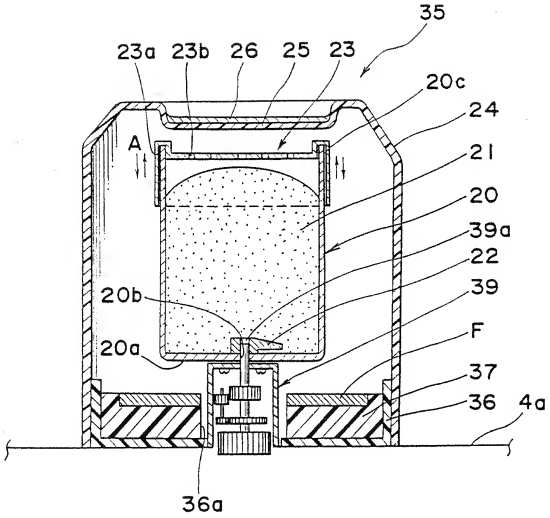

Fig. 4

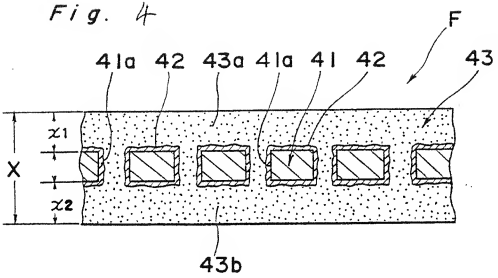

Fig. 5

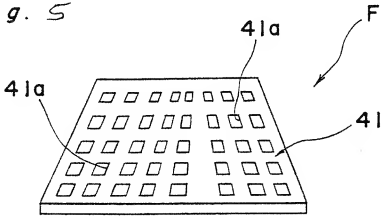

Fig. 6